UTILITY
PATENT APPLICATION
TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

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First Named Inventor or Application Identifier	
KAZUHIRO NAKATA	
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APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. [ ] Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)

2. [X] Specification   *Total Pages* [34]

3. [X] Drawing(s) *(35 USC 113)*   *Total Sheets* [11]

4. [X] Oath or Declaration   *Total Pages* [1]

   a. [X] Newly executed (original or copy)

   b. [ ] Unexecuted for information purposes

   c. [ ] Copy from a prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 17 completed)
[Note Box 5 below]

     i. [ ] DELETION OF INVENTOR(S)
Signed Statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).

5. [ ] Incorporation By Reference *(useable if Box 4c is checked)*
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4c, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

6. [ ] Microfiche Computer Program *(Appendix)*

7. Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)

   a. [ ] Computer Readable Copy

   b. [ ] Paper Copy (identical to computer copy)

   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [X] Assignment Papers (cover sheet & document(s))

9. [ ] 37 CFR 3.73(b) Statement
(when there is an assignee)   [X] Power of Attorney

10. [ ] English Translation Document *(if applicable)*

11. [ ] Information Disclosure Statement (IDS)/PTO-1449   [ ] Copies of IDS Citations

12. [ ] Preliminary Amendment

13. [X] Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)

14. [ ] Small Entity Statement(s)   [ ] Statement filed in prior application Status still proper and desired

15. [ ] Certified Copy of Priority Document(s)
(if foreign priority is claimed)

16. [ ] Other: _____
_____
_____

17. If a CONTINUING APPLICATION, *check appropriate box and supply the requisite information:*
[ ] Continuation   [ ] Divisional   [ ] Continuation-in-part (CIP)   of prior application No. __ / _____

18. CORRESPONDENCE ADDRESS

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CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS (37 CFR 1.16(c))	16-20 =	-	X $ 18.00 =	$ -
	INDEPENDENT CLAIMS (37 cfr 1.16(b))	9-3 =	6	X $ 78.00 =	$ 468.00
	MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1.16(d))			$260.00 =	$ -
				BASIC FEE (37 CFR 1.16(a))	$ 760.00
				Total of above Calculations =	$1228.00
	Reduction by 50% for filing by small entity (Note 37 CFR 1.9, 1.27, 1.28).				-
				TOTAL =	$1228.00

19. Small entity status

   a. ☐ A Small entity statement is enclosed

   b. ☐ A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.

   c. ☐ Is no longer claimed.

20. ☒ A check in the amount of $ 1228.00 to cover the filing fee is enclosed.

21. ☒ A check in the amount of $ 40.00 to cover the recordal fee is enclosed.

22. The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 06-1205:

   a. ☒ Fees required under 37 CFR 1.16.

   b. ☐ Fees required under 37 CFR 1.17.

   c. ☐ Fees required under 37 CFR 1.18.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED	
NAME	David L. Schaeffer, RN 32,716
SIGNATURE	David L. Schaeffer
DATE	7/29/99

NY_MAIN 18633v1

TITLE OF THE INVENTION

DATA PROCESSING METHOD, DATA PROCESSING APPARATUS AND

IMAGE PRINTING APPARATUS

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BACKGROUND OF THE INVENTION

This invention relates to a method of processing
data that has been stored in a storage device, a data
10 processing apparatus used upon being connected to a
storage device, and an image printing apparatus in which
such a data processing apparatus is built-in.

Serial printers are in wide use as printers that
can be constructed in small size and at low cost. Among
15 the serial printers, ink-jet printers, in particular,
have undergone remarkable development in recent years as
printers capable of printing quietly and at high speed,
and the capabilities of these printers have been
enhanced. For example, in regard to printing speed,
20 higher speed has been achieved by raising the scanning
speed of the carriage that carries the printhead.
Meanwhile, printing quality has been improved greatly by
techniques such as raising the definition of images by
improving image resolution.
25 However, there is increasing demand to achieve even
higher printing speed and printing quality at the same

time, and this has led to certain problems that need to be solved.

For example, a well-known technique for improving printing quality through higher resolution is to drive the nozzles of the printhead in time-division fashion. Specifically, the load on the power supply is alleviated by reducing the peak value of current needed to drive the printhead. In addition, by driving adjacent nozzles at different timings, vibration of the ink, within the printhead that accompanies jetting of the ink drops, is reduced, thereby improving the ink jetting characteristic of the printhead. When printing is performed utilizing this technique, there are instances where attainment of higher printing speed is hampered because data processing takes too much time.

This problem will be described taking as an example an ink-jet printer which prints at 1440 dpi (in the horizontal direction). The printer has a ink-jet head on which 128 ink-jet nozzles are arrayed vertically at intervals of 1/360 of an inch. Ink drops are jetted from the nozzles toward print paper while the ink-jet head is scanned horizontally relative to the print paper, thereby performing printing on the print paper.

Fig. 2 is a timing chart representing the driving sequence of the printhead. Since time-division drive is performed based upon division by 4, the 128 nozzles of

the printhead are driven at four timings. Adjacent nozzles are driven at different timings, and nozzles driven simultaneously are those of every other four dots.

5   Since the serial printer drives the print head while causing it to travel along the print paper, any deviation in drive timing results in a deviation in the position of dots on the print paper. With the driving method shown in Fig. 2, the rows of dots are formed in

10   the shape of a sawtooth because of the time difference resulting from time division. Therefore, in a case where a printhead is driven by time division, measurements need to be taken so that print deviation will not be caused by a time difference in drive timing.

15   An example of a method of preventing print deviation involves arraying the nozzles obliquely, relative to the direction of transport, at an angle that corresponds to the printing deviation.

       Fig. 3A illustrates the 1st through 20th nozzles

20   arrayed at an angle on the upper end of the printhead. Since the nozzles are thus arrayed, the printhead itself is mounted on the carriage at an incline of 3.58° with respect to a vertical line on the print paper. In other words, the printhead has an incline of 1/360 of an inch

25   in the horizontal direction per 16 nozzles in the vertical direction. The carriage is scanned

horizontally (to the right in Fig. 3A) relative to the print paper.

Fig. 3B is a diagram showing a dot array formed on print paper by the driving sequence of Fig. 2 under these conditions. Since a deviation in drive timing resulting from time-division drive is canceled out by the inclination of the printhead, the dots that correspond to the 1st to 4th nozzles are arranged vertically. Further, the dots that correspond to the 5th to 8th nozzles are arranged vertically and spaced 1/1440 of an inch to the right of the above-mentioned dots. Because this ink-jet printer prints at 1440 dpi, the dots spaced to the right by 1/1440 of an inch form a row of dots adjacent on the right side. The same holds true for the other nozzles, in which an adjacent row of dots spaced to the right by 1/1440 of an inch is formed every four nozzles. By driving the printhead one full cycle, therefore, dot rows in the form of a staircase are formed over 32 rows on the print paper.

Fig. 4 is a diagram showing a data array in a print buffer. Since the print buffer stores print data immediately before it is output to the printhead, the buffer is an area provided in a RAM possessed by the printer. The area is capable of storing print data in the vertical direction equivalent to the size (128 dots) of the printhead and in the horizontal direction

equivalent to the width of the print paper. Each

rectangle bounded by the solid lines in Fig. 4 indicate

one byte of print data. The rows of dots printed by

driving the printhead one time have the shape of a

5   staircase, as shown in Fig. 3B. Therefore, in a case

where the data is transferred to the printhead from the

print buffer, it is necessary to read the data out of

the print buffer in staircase fashion, as indicated by

the shaded portions in Fig. 4.

10   The problem that arises here is than when data is

read from and written to a RAM, inclusive of a print

buffer, one byte, i.e., eight bits, is the smallest unit

in which reading and writing can take place.

Accordingly, in order to read out the four bits from one

15   of the shaded portions in Fig. 4, e.g., data K1, one

byte of data that includes K1 must be read out.

Consequently, in order to read out 128 bits of data from

K1 to K32, it becomes necessary to read out data of

twice the number of bits, namely 256 bits of data.

20   Because of the processing for reading out of the excess

data, an increase in printing speed is prevented.

SUMMARY OF THE INVENTION

25

Accordingly, an object of the present invention is

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to provide a data processing method and apparatus in which it is possible to raise the efficiency with which data is read out of a print buffer at the time of time-division drive, as well as an image printing apparatus

5   capable of printing at high speed and resolution by using this data processing apparatus.

According to the present invention, the foregoing object is attained by providing a data processing method for processing data stored in a print buffer within an

10   image printing apparatus subjected to time-division drive, comprising a step of rearranging the data in such a manner that one word of data corresponding to a plurality of contiguous nozzles provided on a printhead of the image printing apparatus will become one row in

15   the print buffer.

Further, the present invention provides a data processing apparatus for processing data stored in a print buffer within an image printing apparatus subjected to time-division drive, wherein the data is

20   rearranged in such a manner that one word of data corresponding to a plurality of contiguous nozzles provided on a printhead of the image printing apparatus will become one row in the print buffer.

The data processing apparatus comprises first

25   storage means for storing data of a plurality of words, and delay means for delaying an amount of data that

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corresponds to a whole-number multiple of a number of time divisions employed in time-division drive, the delayed data being from the data that has been read out of the first storage means.

5   Preferably, storage means for a horizontal-to-vertical conversion is used as the first storage means.

Further, the present invention provides an image printing apparatus subjected to time-division drive in which n represents the number of time divisions and one

10   word is composed of m bits, comprising data processing means for storing contiguous 1-bit data in one row within a print buffer, the data being from data output by driving the apparatus one time and n-bit data corresponding to n-number of contiguous nozzles serving

15   as one unit, where the lowest common multiple of n and m is l.

Further, the present invention provides an image printing apparatus for processing data in which one word consists of eight bits, comprising: printhead driving

20   means for discharging ink from four contiguous nozzles of a printhead at different timings; a print buffer for outputting image data to the printhead driving means; and data transfer means for transferring data to the print buffer; said data transfer means rearranging sets

25   of 4-bit data, each set of which corresponds to four contiguous nozzles of the printhead, in such a manner

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that two sets of data are rendered contiguous.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the principal circuit components of a printer according to a first embodiment of the present invention;

Fig. 2 is a timing chart showing the driving sequence of a printhead;

Figs. 3A, 3B are diagrams showing the relationship between an array of nozzles of a printhead and an array of printed dots;

Fig. 4 is a diagram showing the array of data in a print buffer according to an example of the prior art;

Fig. 5 is a block diagram showing the principal circuit components of a transfer circuit according to the first embodiment of the present invention;

Fig. 6 is a timing chart showing the operation of a transfer circuit according to the first embodiment;

Figs. 7A to 7C are diagrams showing data arrays at

a transfer source and transfer destination in the first

embodiment;

Fig. 8 is a diagram showing an array of data in a

print buffer;

5   Figs. 9A, 9B are diagrams showing data arrays in a

transverse-to-longitudinal conversion;

Fig. 10 is a block diagram showing the principal

circuit components of a transfer circuit according to

the second embodiment of the present invention; and

10   Fig. 11 is a timing chart showing the operation of

a transfer circuit according to the second embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

15   Preferred embodiments of the present invention will

now be described in detail with reference to the

drawings.   Unless it is specifically stated otherwise,

the relative placement of components and numerical

values such as resolution set forth in the embodiments

20   do not impose a limitation upon the scope of the

invention.

[First Embodiment]

A printer serving as a first embodiment of an image

printing apparatus according to the present invention

25   will now be described.   The printer of this embodiment

is one which drives a printhead in accordance with the

sequence illustrated in the timechart of Fig. 2, and the printhead is arranged as shown in Fig. 3(A) and forms dots in an array of the kind shown in Fig. 3B by a single driving cycle of the printhead.

5   Fig. 1 is a block diagram showing the principal circuit components of a circuit for controlling the printer according to the first embodiment of the present invention. The arrangement of Fig. 1 includes a CPU 1, a ROM 2, a parallel interface (PIF) 3, a printer control

10   integrated circuit (PC) 4, a RAM 5 and a printhead 6. The printer control IC 4 has a transfer circuit (TC) 7.

The CPU 1, which controls the overall operation of the printer, incorporates a timer function and input/output ports in addition to a processor section

15   for executing programs. The ROM 2 stores programs executed by the CPU 1 and various data necessary for control. The parallel interface 3, which is connected to a host system such as a computer, receives print data and commands. The printer control IC 4 controls the

20   parallel interface 3, RAM 5 and printhead 6 based upon commands from the CPU 1. The printer control IC 4 incorporates the transfer circuit 7. The RAM 5 is a dynamic RAM, in which 16 bits is the width of one pass. The RAM 5 is used to store received datan image data and

25   the like. As shown in Fig. 3A, the printhead 6 is an ink-jet printhead on which 128 ink-jet nozzles are

arrayed vertically at intervals of 1/360 of an inch.

Ink drops are jetted from the nozzles toward print paper

while the ink-jet head is scanned horizontally relative

to the print paper, thereby performing printing on the

5   print paper.

Data that has been received by the parallel

interface 3 is stored temporarily in a receive register

within the printer control IC 4 and then is stored in a

receive buffer area set up in the RAM 5. The CPU 1

10   checks to see whether or not data has been stored in the

receive buffer and, if received data has been stored in

the receive buffer, analyzes the received data. Image

data that was created by expanding compressed data is

stored by the CPU 1 in an editing buffer area set up in

15   the RAM 5. The transfer circuit 7 transfers the data in

the editing buffer to a print buffer set up in the RAM

5.

Fig. 5 is a block diagram showing the principal

components of the transfer circuit 7. The transfer

20   circuit 7 includes a 16-bit register 21, a 4-bit

register 22, a transfer control circuit 23 and an

address generating circuit 24. The 16-bit register 21

is expressed by being divided into 4-bit registers in

order to make it easier to comprehend the flow of data.

25   Sixteen-bit data that has been read out of the

editing buffer in RAM 5 passes through the input buffer

of the printer control IC 4 and is stored in the 16-bit register 21 as input data signals ID15 to ID0. The stored data is written to the print buffer in RAM 5, through the output buffer of the printer control IC 4,

5   as output data signals OD15 to OD0. At this time data that has been stored in the 4-bit register 22 is output as the output signals OD15 to OD12. Initially all "0"s are stored in the 4-bit register 22.

Of the data output from the 16-bit register 21,

10 data corresponding to ID11 to ID8 is output as OD11 to OD8, data corresponding to ID15 to ID12 is output as OD7 to OD4, and data corresponding to ID3 to ID0 is output as OD3 to OD. When the writing of data to the print buffer is completed, the data corresponding to ID7 to

15 ID4, which is among the data output by the 16-bit register 21, is stored in the 4-bit register 22. The above-described operation is controlled by the transfer control circuit 23. Addresses of the RAM 5 when data is read out and data is written in are generated by the

20 address generating circuit 24.

Fig. 6 illustrates a timing chart for when the transfer circuit 7 transfers data. Here D15 to D0 represent data signals of the RAM 5, and ADDRESS represents an address signal. Further, R/WX represents

25 a read/write signal, in which "1" signifies read-out and "0" signifies write. The R/WX signal is converted to a

signal, which is suited to control of the RAM 5, in a DRAM control circuit (not shown) within the printer control IC 4. In Fig. 6, A to H of the data signals are symbols of convenience assigned in 4-bit units to

5   facilitate and understanding of the flow of data.

When transfer starts, the transfer circuit outputs a transfer-origin address SA as an address signal and reads data A to D output of the editing buffer in RAM 5. A data transfer is performed simultaneously to transfer

10 16 bits, i.e., two bytes, whereas addresses are provided in byte units. Data of an address SA+1, therefore, also is output at the same time. When read-out ends, the transfer circuit outputs a transfer-destination address DA as an address signal and writes the data to the print

15 buffer in RAM 5. When a write operation is performed, data is written also to the address DA+1 simultaneously in a manner similar to that of read-out. At the time of the write operation, the "0" that was initially stored in the 4-bit register 22 is written as data D15 to D12.

20 When writing ends, data is then read out of transfer-origin address SA+2 and data is written to transfer-destination address DA+2. At this time data C, which was read out at the time of the immediately preceding transfer and stored in the 4-bit register 22, is written

25 as data D15 to D12. Thereafter, and in similar fashion, data transfer is performed a prescribed number of times.

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In other words, data transfer commensurate with the
width of the paper is carried out.

Fig. 7A illustrates a data array in the editing
buffer of the transfer origin, Fig. 7B a data array in
5   the print buffer of the transfer destination, and Fig.
7C the addresses of the respective buffers. One byte of
data in the editing buffer signifies eight dots of image
data vertically. Data obtained by rendering the eight
dots of vertical image data continuous in the horizontal
10   direction by an amount commensurate with the width of
the paper makes up the editing buffer. When the data in
the editing buffer is transferred to the print buffer by
the transfer circuit 7, the upper four dots of data are
shifted in their entirety one column to the right of the
15   diagram through the operation described earlier.

Data is output from the editing buffer in the array
(see Fig. 4) stored in the conventional print buffer.
However, by performing the above-described operation for
128 longitudinal dots, i.e., for 16 bytes, in regard to
20   this output data, the data is stored in the print buffer
in an array illustrated in Fig. 8. The shaded portions
in Fig. 8 represent print data printed by driving the
printhead one time. Of the data indicated by shading in
Fig. 8, K1 and K2, for example, form one byte of data,
25   and therefore this data can be read out at one time. In
addition, data K3 and K4 and data K5 and K6 can also be

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read out simultaneously in the same manner. Since only data that takes part in printing is read out when the printhead is driven, reading out 128 bits of data suffices in order to print 128 dots.

5   Thus, the data is rearranged in such a manner that one word of data corresponding to a plurality of contiguous nozzles provided on the printhead of the image printing apparatus becomes one row in the print buffer. As a result, it becomes possible to read data
10   out of the print buffer more efficiently that in the prior art and printing speed can be increased.

Further, with the construction of the embodiment described above, a register for 20 bits is sufficient and, hence, there is little influence upon the
15   productivity of the apparatus.

[Second Embodiment]

A second embodiment of the present invention is illustrated in Figs. 9A, 9B and Fig. 10.

In the first embodiment, an independent data
20   transfer circuit is provided and the arrangement of data is performed between the editing buffer and the print buffer. In the second embodiment, however, data is rearranged by improving a horizontal-to-vertical conversion circuit. The horizontal-to-vertical
25   conversion and the method of improvement will now be described.

In a case where a host computer outputs image data to a printer, often the data is output in a raster format expressed by rows of dots in the horizontal direction. In a serial printer, on the other hand, the printing elements, e.g., ink-jet nozzles, of the printhead are arrayed in the vertical direction. Consequently, it is necessary eventually to process the image data as data arrayed in the vertical direction. In a serial printer, therefore, processing referred to as a horizontal-to-vertical conversion often is executed. More specifically, the method generally employed includes providing a register having N dots in the horizontal direction and M dots in the vertical direction, reading data that is data arrayed in the horizontal direction out of N x M dots of memory, storing the data temporarily in the register and controlling the sequence of data read-out from the register, thereby writing the data to the memory as data arrayed in the vertical direction.

Figs. 9A, 9B are diagrams useful in describing a horizontal-to-vertical conversion of 16 dots (horizontal direction) × 8 dots (vertical direction). Sixteen dots of data at the transfer source shown in Fig. 9A are read out of transfer-source addresses SA and SA+1 as two bytes of data R1 and written to a horizontal-to-vertical conversion register in the printer control IC. Next,

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R2, which is data one line below R1, is read out of transfer-source addresses SA+H and SA+H+1. Since addresses storing data are contiguous in the horizontal direction in the case of raster data, the addresses of

5 the data of the underlying line are spaced away by H, which corresponds to the width of the print paper. By thenceforth reading out data up to R8 in the same manner, the data of 16 dots (horizontal direction) × 8 dots (vertical direction) is stored in the horizontal-

10 to-vertical conversion register. Next, from the data thus stored, data C1, which corresponds to two columns, is written from the left to transfer-destination addresses DA and DA+1 as two bytes of data. By thenceforth writing data up to data C8 in the same

15 manner, the addresses become as shown in Fig. 9B at the transfer destination, thereby completing the horizontal-to-vertical conversion of a block of data consisting of 16 dots (horizontal direction) × 8 dots (vertical direction).

20 Fig. 10 is a block diagram showing the principal components of the transfer circuit improved in order to perform rearrangement of data at the same time as the horizontal-to-vertical conversion.

The transfer circuit shown in Fig. 10 includes a

25 128-bit [16 dots (horizontal direction) × 8 dots (vertical direction)] horizontal-to-vertical conversion

register 31, and a selector 32 for extracting data,
which has been stored in the horizontal-to-vertical
conversion register 31, as data arrayed in the vertical
direction. The other functional blocks of this transfer

5   circuit are the same as those of the transfer circuit
described earlier in conjunction with Fig. 5.

The operation of the transfer circuit according to
this embodiment will now be described with reference to
Fig. 11.

10   Fig. 11 is a timing chart of the data transfer.
Initially, 16-bit data R1 is read out of address SA (and
SA+1) in the editing buffer area of the RAM and is
stored in the horizontal-to-vertical conversion register
31. By reading out data up to data R8 in a similar

15   manner, data of 16 dots (horizontal direction) × 8 dots
(vertical direction) is prepared in the horizontal-to-
vertical conversion register 31. Next, data C1
corresponding to two rows is selected from the left by
the selector 32 and is written as 2-byte data to address

20   DA (and DA+1) in the print buffer area of the RAM. Data
is written up to data C8 in similar fashion. At this
time the upper four dots of data are shifted in their
entirety one column to the right in a manner similar to
that of the first embodiment. Furthermore, by

25   continuously applying the horizontal-to-vertical
conversion to blocks [data of 16 dots (horizontal

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direction) × 8 dots (vertical direction)] adjacent one
after the other on the right side, it is possible to
shift the upper four dots of data one column to the
right over the entirety of the data commensurate with
5   the width of the paper.

Thus, data that has been prepared in the print
buffer can be read out efficiently, as a result of which
it is possible to raise printing speed, as described in
the first embodiment. Further, in the transfer circuit
10   according to the second embodiment, circuitry required
anew to supplement the horizontal-to-vertical conversion
function provided in the prior art is merely the 4-bit
register, etc. There is almost no risk of a decline in
productivity. Furthermore, the rearrangement of data
15   performed in this embodiment is carried out at the same
time as the horizontal-to-vertical conversion. As a
result, it is unnecessary to transfer data anew and
there is no increase in the amount of data processing.

[Other Embodiment]

20   In the foregoing embodiments, a case in which data
is stored in a print buffer in a data array of the kind
shown in Fig. 8 is described. However, the present
invention is not limited to the data array of Fig. 8,
for it will suffice if the array is such that data
25   corresponding to a plurality of contiguous nozzles is
arrayed in one row, with the number of bits being the

smallest unit read from and written to the RAM. In the

foregoing embodiments, one word is composed of eight

bits, and therefore data of eight bits (e.g., K1 and K2)

corresponding to eight contiguous nozzles is transferred

5   so as to be arrayed in a single row. However, in a case

where one word is composed of 16 bits, it is necessary

that data corresponding to 16 contiguous nozzles be

transferred so as to be arrayed in a single row.

Further, the number of time divisions used in time-

10 division drive is not limited to four. If one word

consists of m bits and the number of time divisions is

n, and if the lowest common multiple of n and m is l,

data can be read out of the print buffer efficiently if

l-bit data is transferred to the print buffer so as to

15 be arranged in a single row.

High-density, high-definition printing can be

achieved especially if these embodiments of the

invention employ ink-jet printing technology using means

(e.g., an electrothermal transducer or laser beam

20 mechanism) for generating thermal energy as the energy

utilized to discharge ink, wherein a change in the state

of the ink is brought about by this thermal energy.

With regard to a typical configuration and

operating principle, it is preferred that the foregoing

25 be achieved using the basic techniques disclosed in the

specifications of USP 4,723,129 and 4,740,796. This

scheme is applicable to both so-called on-demand-type
and continuous-type apparatus. In the case of the on-
demand type, at least one drive signal, which provides a
sudden temperature rise that exceeds that for film

5   boiling, is applied, in accordance with printing
information, to an electrothermal transducer arranged to
correspond to a sheet or fluid passageway holding a
fluid (ink). As a result, thermal energy is produced in
the electrothermal transducer to bring about film

10 boiling on the thermal working surface of the ink-jet
head. Accordingly, air bubbles can be formed in the
fluid (ink) in one-to-one correspondence with the drive
signals. Due to growth and contraction of the air
bubbles, the fluid (ink) is jetted via an orifice so as

15 to form at least one droplet. If the drive signal has
the form of a pulse, growth and contraction of the air
bubbles can be made to take place rapidly and in
appropriate fashion. This is preferred since it will be
possible to achieve fluid (ink) discharge exhibiting

20 excellent response.

Signals described in the specifications of USP
4,463,359 and 4,345,262 are suitable as drive pulses
having this pulse shape. It should be noted that even
better printing can be performed by employing the

25 conditions described in the specification of USP
4,313,124, which discloses an invention relating to the

rate of increase in the temperature of the above-mentioned thermal working surface.

In addition to the combination of the orifice, fluid passageway and electrothermal transducer (in which

5   the fluid passageway is linear or right-angled) disclosed as the construction of the print head in each of the above-mentioned specifications, an arrangement using the art described in the specifications of USP 4,558,333 and 4,459,600, which disclose elements

10 disposed in an area in which the thermal working portion is curved, may be employed. Further, it is possible to adopt an arrangement based upon Japanese Patent Application Laid-Open No. 59-123670, which discloses a configuration having a common slot for the ink discharge

15 portions of a plurality of electrothermal transducers, or Japanese Patent Application Laid-Open No. 59-138461, which discloses a configuration having openings made to correspond to the ink discharge portions, wherein the openings absorb pressure waves of thermal energy.

20   As a print head of the full-line type having a length corresponding to the maximum width of the printing medium capable of being printed on by the printing apparatus, use can be made of an arrangement in which the length is satisfied by a combination of plural

25 print heads of the kind disclosed in the foregoing specifications, or an arrangement in which print heads

serve as a single integrally formed print head.

The print head is not limited to one of the cartridge type, in which the print head itself is integrally provided with an ink tank. The print head

5   may be of the replaceable tip-type, in which the electrical connection to the apparatus proper and the supply of ink from the apparatus proper can be achieved by mounting the head on the apparatus proper.

In order to make the printing operation much more

10   stable, it is referred that the printing apparatus described above be additionally provided with print head recovery means and auxiliary means. Specific examples are print head capping means, cleaning means, pressurizing or suction means, preheating means

15   comprising an electrothermal transducer, a heating element separate from this transducer or a combination of the transducer and the heating element, and a pre-discharge mode for performing a discharge of ink separate from a discharge for printing. These

20   expedients are effective in achieving stable printing.

The printing mode of the printing apparatus is not limited to a printing mode solely for the mainstream colors such as black. The apparatus adopted can be one equipped with at least one print head for a plurality of

25   different colors or one full-color print head using mixed colors, through it is desired that this be

achieved by a print head having an integrated structure
or by a combination of a plurality of print heads.

Further, the foregoing embodiments have been
described on the assumption that ink is the fluid.   The
5   ink used may be one which solidifies at room temperature
or lower, one which softens at room temperature or one
which is a liquid at room temperature.   In general,
temperature control is performed in such a manner that
ink viscosity will fall within a stable ink jetting
10   range by adjusting the temperature of the ink itself so
as to fall within a temperature range of no less than
30°C to no greater than 70°C.   Accordingly, it will
suffice to use an ink liquefied when the printing signal
is applied.

15   In order to positively prevent elevated temperature
due to thermal energy by using this as the energy for
converting the ink from the solid state to the liquid
state, or in order to prevent evaporation of the ink, it
is permissible to use an ink which solidifies when left
20   standing but which is liquefied by application of heat.
In any case, ink which is liquefied for the first time
by thermal energy, such as an ink liquefied by
application of thermal energy conforming to a printing
signal and jetted as a liquid ink, or ink which has
25   already begun to solidify at the moment it reaches the
printing medium, can be applied to the present

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invention. Such inks may be used in a form in which they oppose the electrothermal transducer in a state in which they are held as a liquid or solid in the recesses or through-holes of a porous sheet, as described in

5 Japanese Patent Application Laid-Open Nos. 54-56847 and 60-71260. In the present invention, the most effective method of dealing with these inks is the above-described method of film boiling.

The printing apparatus of the invention may take on

10 the form of an apparatus that is an integral part of or separate from an image output terminal of information processing equipment such as a computer, a copier in combination with a reader or the like, or a facsimile machine having a transmitting/receiving function.

15 The present invention can be applied to a system constituted by a plurality of devices (e.g., a host computer, interface, reader, printer, etc.) or to an apparatus comprising a single device (e.g., a copier or facsimile machine, etc.).

20 Furthermore, it goes without saying that the invention is applicable also to a case where the object of the invention is attained by supplying a storage medium storing the program codes of the software for performing the functions of the foregoing embodiments to

25 a system or an apparatus, reading the program codes with a computer (e.g., a CPU or MPU) of the system or

apparatus from the storage medium, and then executing the program codes.

In this case, the program codes read from the storage medium implement the novel functions of the invention, and the storage medium storing the program codes constitutes the invention.

Further, the storage medium, such as a floppy disk, hard disk, optical disk, magneto-optical disk, CD-ROM, CD-R, magnetic tape, non-volatile type memory card or ROM can be used to provide the program codes.

Furthermore, besides the case where the aforesaid functions according to the embodiments are implemented by executing the program codes read by a computer, it goes without saying that the present invention covers a case where an operating system or the like running on the computer performs a part of or the entire process in accordance with the designation of program codes and implements the functions according to the embodiments.

It goes without saying that the present invention further covers a case where, after the program codes read from the storage medium are written in a function extension board inserted into the computer or in a memory provided in a function extension unit connected to the computer, a CPU or the like contained in the function extension board or function extension unit performs a part of or the entire process in accordance

with the designation of program codes and implements the function of the above embodiments.

In accordance with the embodiments described above, it is possible to array print data in a print buffer in
5   a form suited to read-out by implementing a data processing method which shifts only a portion of transfer data to subsequent transfer data. Since data can be read out of the print buffer efficiently, it is possible to raise the printing speed of an image
10   printing apparatus.

Furthermore, in the present invention, a data rearranging function is combined with a horizontal-to-vertical conversion. As a result, it is possible to array print data in a print buffer in a form suited to
15   read-out without inviting a decline in productivity due addition of new circuitry or an increase in amount of data processing due to transfer of data anew.

As many apparently widely different embodiments of the present invention can be made without departing from
20   the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

WHAT IS CLAIMED IS:

1. A data processing method for processing data stored in a print buffer in an image printing apparatus subjected to time-division drive, comprising a step of:

5   rearranging the data in such a manner that one or more address regions in the print buffer are occupied with one word of data corresponding to a plurality of contiguous print elements provided on a printhead of the image printing apparatus.

10

2. A data processing apparatus for processing data stored in a print buffer in an image printing apparatus subjected to time-division drive, wherein the data is rearranged in such a manner that one or more address

15 regions in the print buffer are occupied with one word of data corresponding to a plurality of contiguous print elements provided on a printhead of the image printing apparatus.

20 3. The apparatus according to claim 2, comprising:
      first storage means for storing data of a plurality of words; and

      delay means for delaying an amount of data that corresponds to a whole-number multiple of a number of

25 time divisions employed in time-division drive, said delayed data being from the data that has been read out

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of said first storage means.

4.   The apparatus according to claim 3, wherein storage
means for a horizontal-to-vertical conversion is used as
5   said first storage means.

5.   An image printing apparatus subjected to time-
division drive in which n represents the number of time
divisions and one word is composed of m bits,
10   comprising:

data processing means for storing contiguous 1-bit
data (where the lowest common multiple of n and m is l)
in one row within a print buffer, said data being from
data output by driving the apparatus one time;
15   wherein n-bit data corresponding to n-number of
contiguous nozzles serves as one unit.

6.   An image printing apparatus for processing data in
which one word consists of eight bits, comprising:
20   printhead driving means for discharging ink from
four contiguous nozzles of a printhead at different
timings;

a print buffer for outputting image data to said
printhead driving means; and
25   data transfer means for transferring data to said
print buffer;

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said data transfer means rearranging sets of 4-bit data, each set of which corresponds to four contiguous nozzles of the printhead, in such a manner that two sets of data are rendered contiguous.

5

7. An image printing apparatus subjected to time-division drive, comprising:

storage means for storing image data;

a printhead for performing printing based upon the

10 image data read out of said storage means; and

means for packing image data, which will be printed by driving said printhead one time, before the image data is transmitted to said printhead, the image data being packed in numbers of bits serving as units in

15 which data is read from and written to said storage means.

8. A method of controlling an image printing apparatus subjected to time-division drive and having storage

20 means for storing image data and a printhead for performing printing based upon the image data read out of said storage means, said method comprising a step of:

packing image data, which will be printed by driving said printhead one time, before the image data

25 is transmitted to said printhead, the image data being packed in numbers of bits serving as units in which data

is read from and written to said storage means.

9. A computer-readable memory storing a control program for controlling an image printing apparatus subjected to time-division drive and having storage means for storing image data and a printhead for performing printing based upon the image data read out of said storage means, said control program being a program for packing image data, which will be printed by driving said printhead one time, before the image data is transmitted to said printhead, the image data being packed in numbers of bits serving as units in which data is read from and written to said storage means.

10. The method according to claim 1, wherein the print element comprises a nozzle to discharge ink.

11. The method according to claim 2, wherein the print element comprises a nozzle to discharge ink.

12. A data processing method for processing data stored in a print buffer in an image printing apparatus which performs printing by causing a printhead to scan, said printhead having a plurality of print elements arrayed at predetermined angles with respect to the scanning direction of the printhead and subjected to time-

division drive, comprising a step of:

rearranging the data in such a manner that one or more address regions in the print buffer are occupied with one word of data corresponding to a plurality of

5   contiguous print elements provided on a printhead of the image printing apparatus.

13.   The method according to claim 12, wherein the print element comprises a nozzle to discharge ink.

10

14.   A data processing apparatus for processing data stored in a print buffer in an image printing apparatus which performs printing by causing a printhead to scan, said printhead having a plurality of print elements

15   arrayed at predetermined angles with respect to the scanning direction of the printhead and subjected to time-division drive, wherein the data is rearranged in such a manner that one or more address regions in the print buffer are occupied with one word of data

20   corresponding to a plurality of contiguous print elements provided on a printhead of the image printing apparatus.

15.   The apparatus according to claim 14, comprising:

25   first storage means for storing data of a plurality of words; and

delay means for delaying an amount of data that corresponds to a whole-number multiple of a number of time divisions employed in time-division drive, said delayed data being from the data that has been read out of said first storage means.

16. The method according to claim 14, wherein the print element comprises a nozzle to discharge ink.

ABSTRACT OF THE DISCLOSURE

Discloses a method of raising the printing speed of image printing device when time-division drive is performed. In time-division drive using four time

5   divisions, image data is read out of the editing buffer of a RAM in regular order, in the form of a staircase, four dots at a time, and the image data is rearranged in the form of a staircase of eight dots in a print buffer within the same RAM. This makes it possible to transmit

10   data from the RAM to a printhead one byte at a time in an efficient manner.

F I G. 1
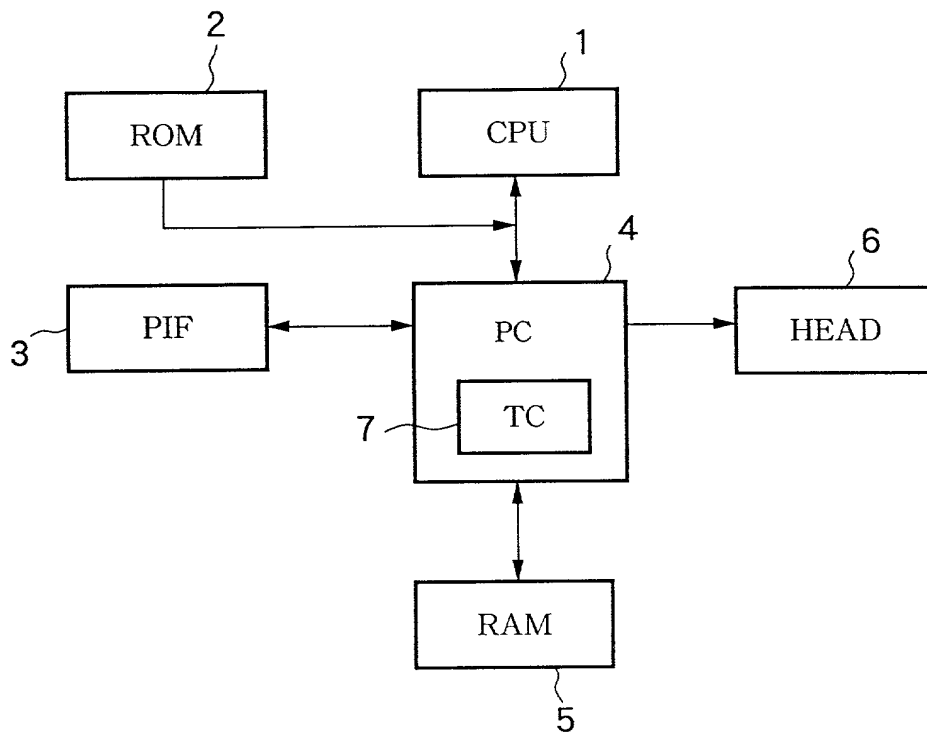
FIG. 2
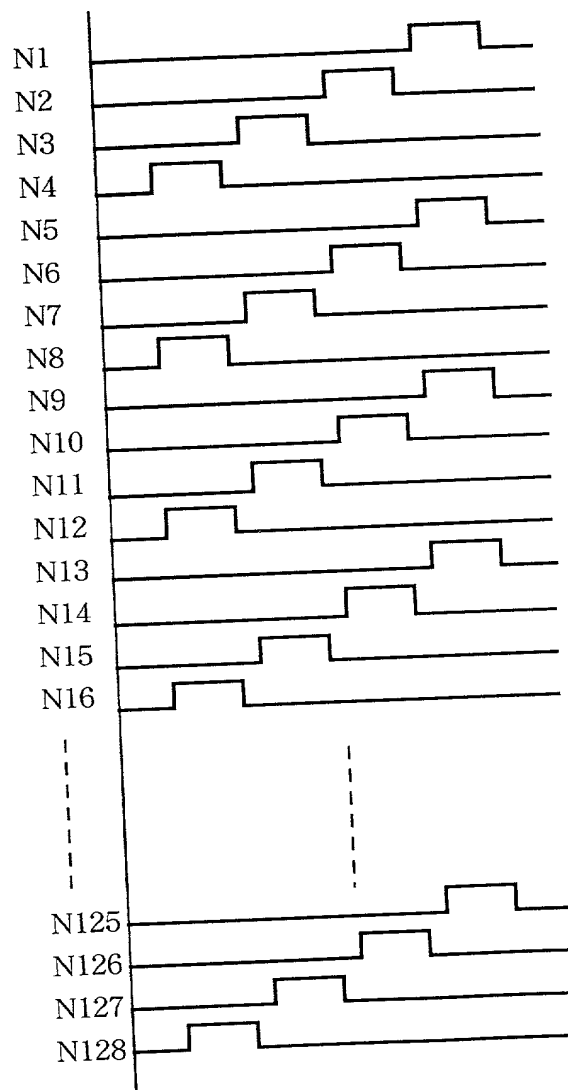
L : 1/360 OF AN INCH
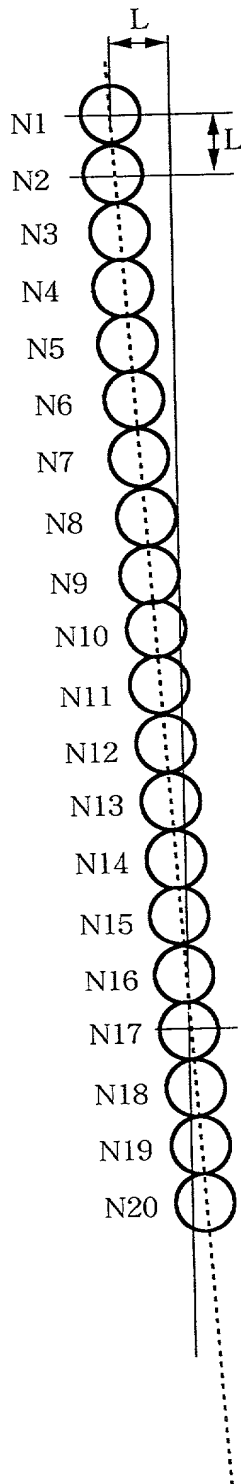
L : 1/360 OF AN INCH

N1
N2
N3
N4
N5
N6
N7
N8
N9
N10
N11
N12
N13
N14
N15
N16
N17
N18
N19
N20

N1
N2
N3
N4
N5
N6
N7
N8
N9
N10
N11
N12
N13
N14
N15
N16
N17
N18
N19
N20

F I G. 3A   F I G. 3B

F I G. 4

FIG. 5

F I G. 6

D15 – D12	A	"0"	E	C
D11 – D8	B	B	F	F
D7 – D4	C	A	G	E
D3 – D0	D	D	H	H
ADDRESS	SA	DA	SA+2	DA+2
R/WX				

F I G. 7A

TRANSFER-SOURCE DATA

ADDRESS   SA   SA+2   - - - - - - - - - - - - - - - -

              SA+1   SA+3

A	C	E	G	- - - - - - - - - - - - - -

DATA

B	D	F	H	- - - - - - - - - - - - - -

F I G. 7B

TRANSFER-DESTINATION DATA

ADDRESS   DA   DA+2   - - - - - - - - - - - - - - - -

              DA+1   DA+3

	A	C	E	- - - - - - - - - - - - - -

DATA

B	D	F	H	- - - - - - - - - - - - - -

F I G. 7C

ADDRESS AND DATA ARRAYS

ADDRESS

EVEN- NUMBERED	ODD- NUMBERED
D15	D7
⋮	⋮
D12	D4
D11	D3
⋮	⋮
D8	D0

DATA

FIG. 8
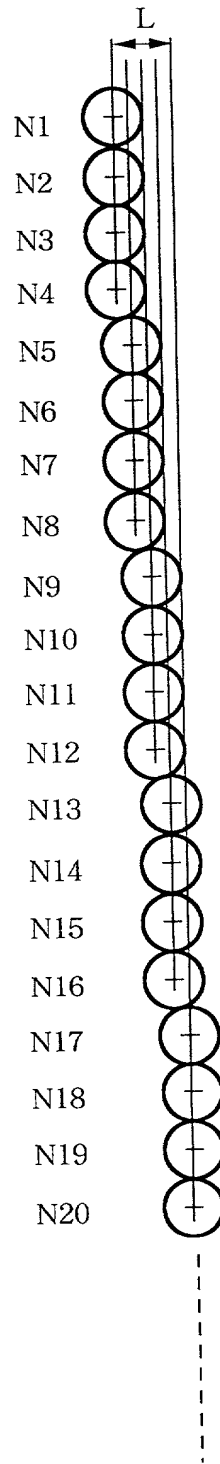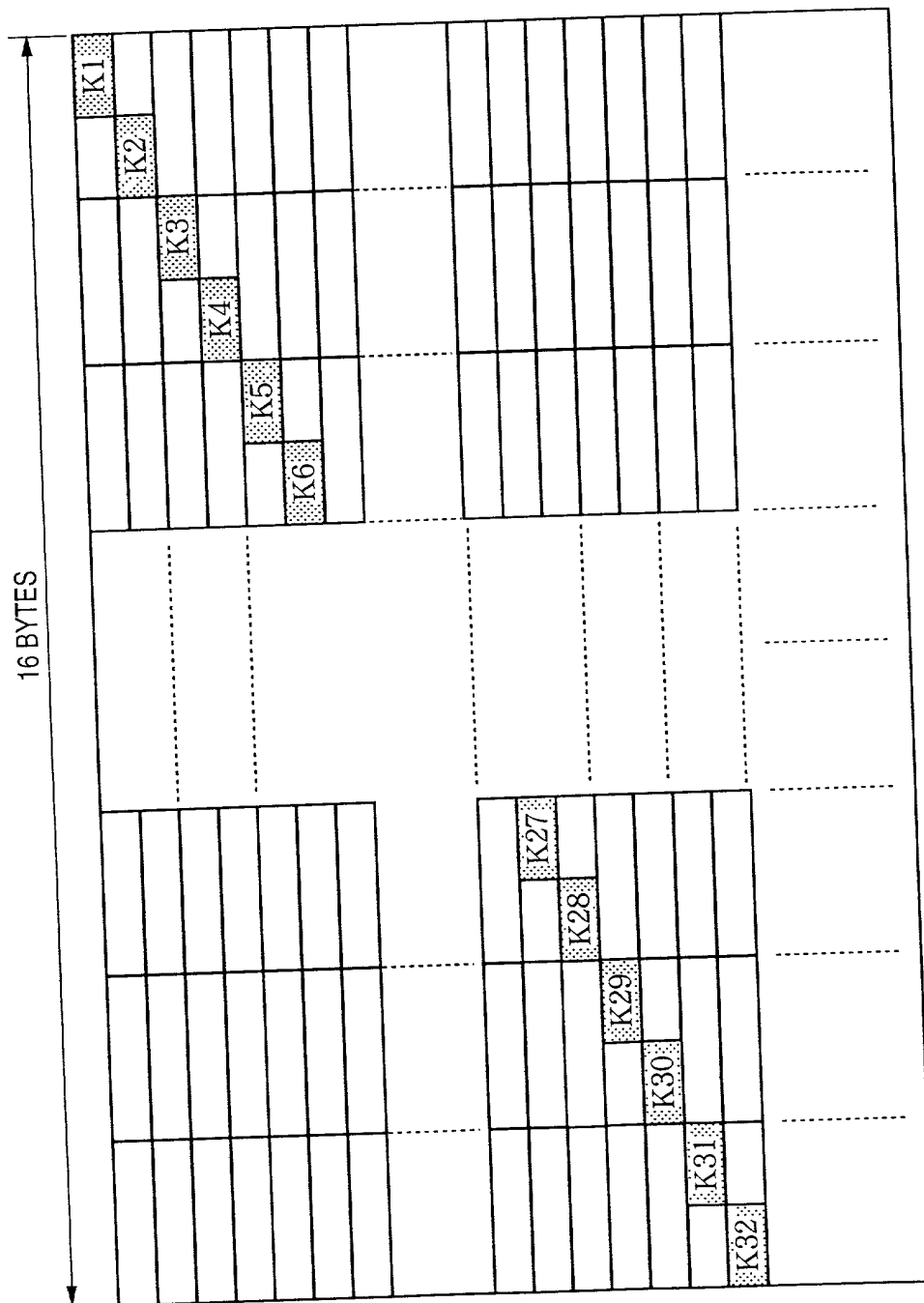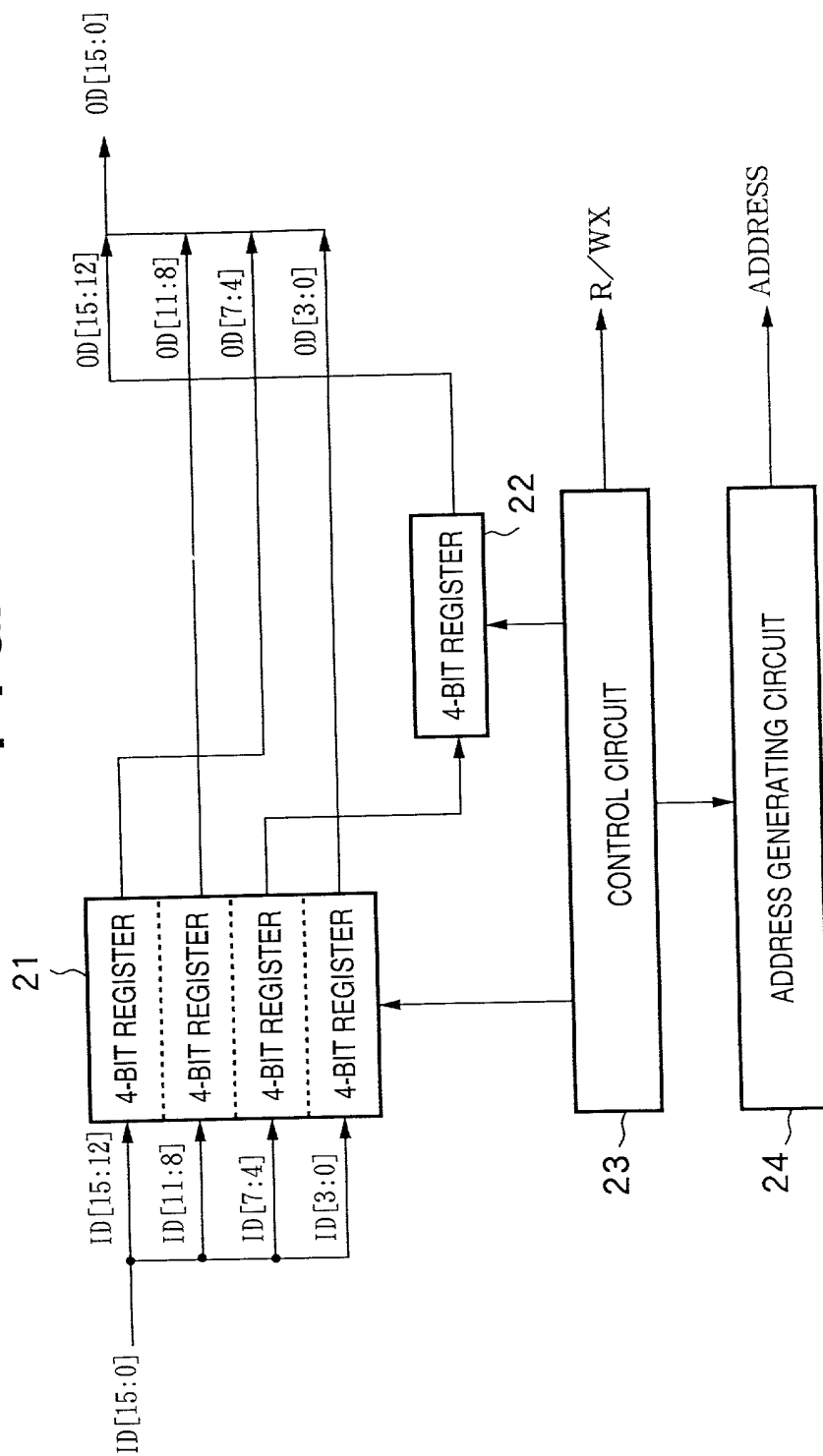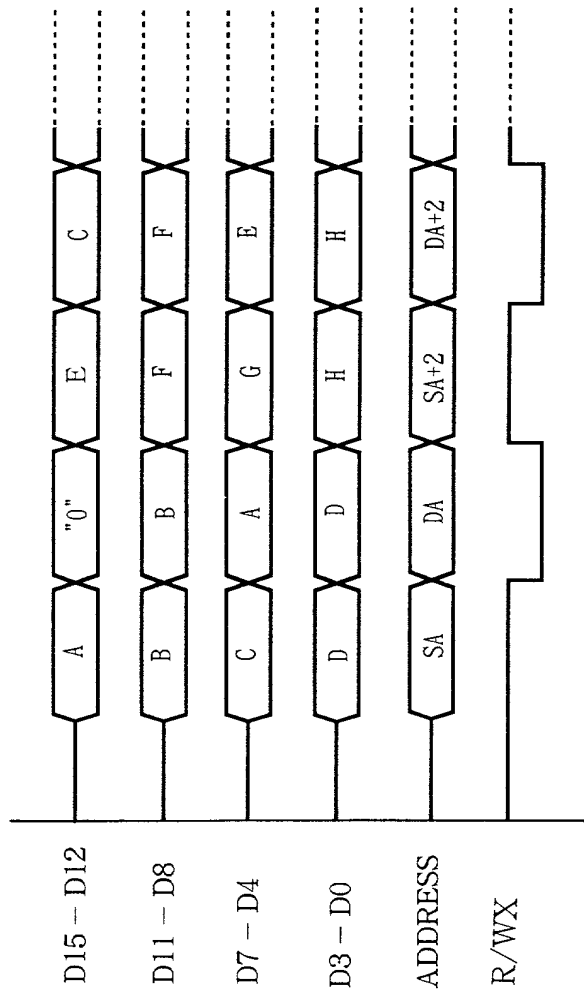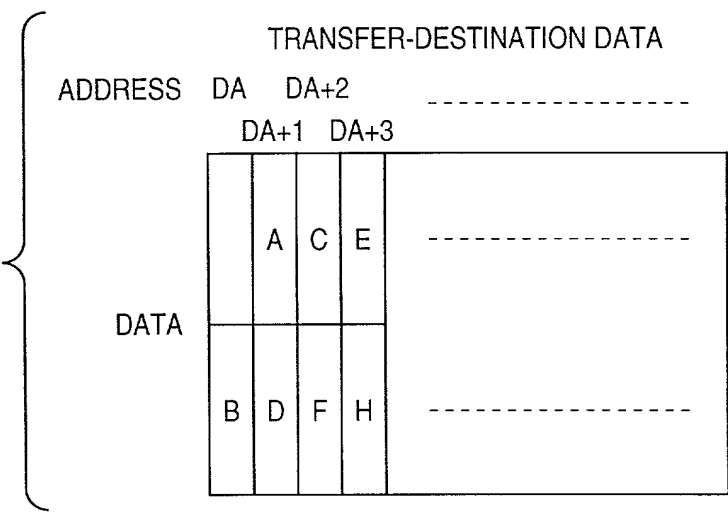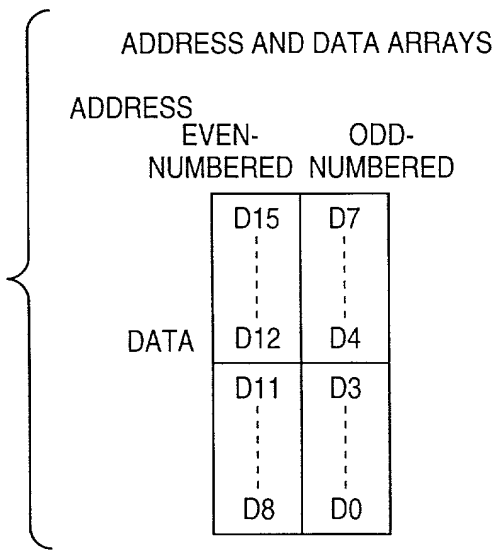
TRANSFER-SOURCE DATA

ADDRESS		DATA	
SA	D15	R1	D0
SA+H	D15	R2	D0
SA+2H	D15	R3	D0
SA+3H	D15	R4	D0
SA+4H	D15	R5	D0
SA+5H	D15	R6	D0
SA+6H	D15	R7	D0
SA+7H	D15	R8	D0

F I G. 9A

TRANSFER-DESTINATION DATA

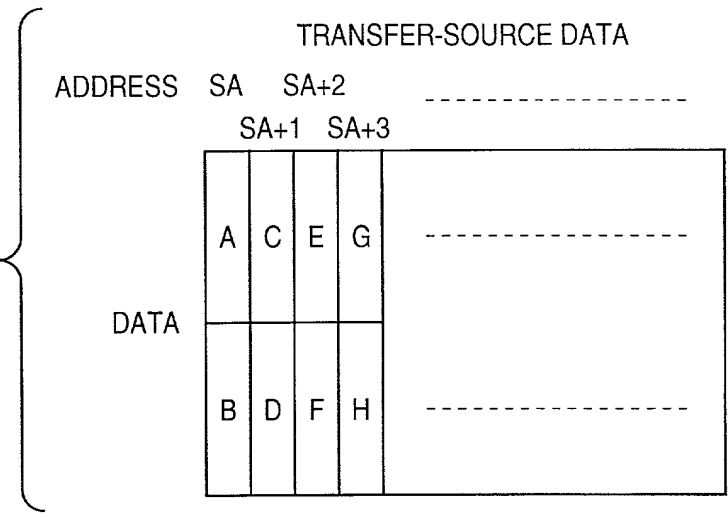| ADDRESS	DA	DA+1	DA+2	DA+3	DA+4	DA+5	DA+6	DA+7	DA+8	DA+9	DA+10	DA+11	DA+12	DA+13	DA+14	DA+15
	D15	D7	D15	D7	D15	D7	D15	D7	D15	D7	D15	D7	D15	D7	D15	D7
DATA	C1		C2		C3		C4		C5		C6		C7		C8	
	D8	D0	D8	D0	D8	D0	D8	D0	D8	D0	D8	D0	D8	D0	D8	D0

F I G. 9B

FIG. 10

FIG. 11

DATA	R1	R2	R3	R4	R5	R6	R7	R8	C1	C2	C3	C4	C5	C6	C7	C8
ADDRESS	SA	SA+H	SA+2H	SA+3H	SA+4H	SA+5H	SA+6H	SA+7H	DA	DA+2	DA+4	DA+6	DA+8	DA+10	DA+12	DA+14
R/WX																

COMBINED DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION
(Page 1)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;
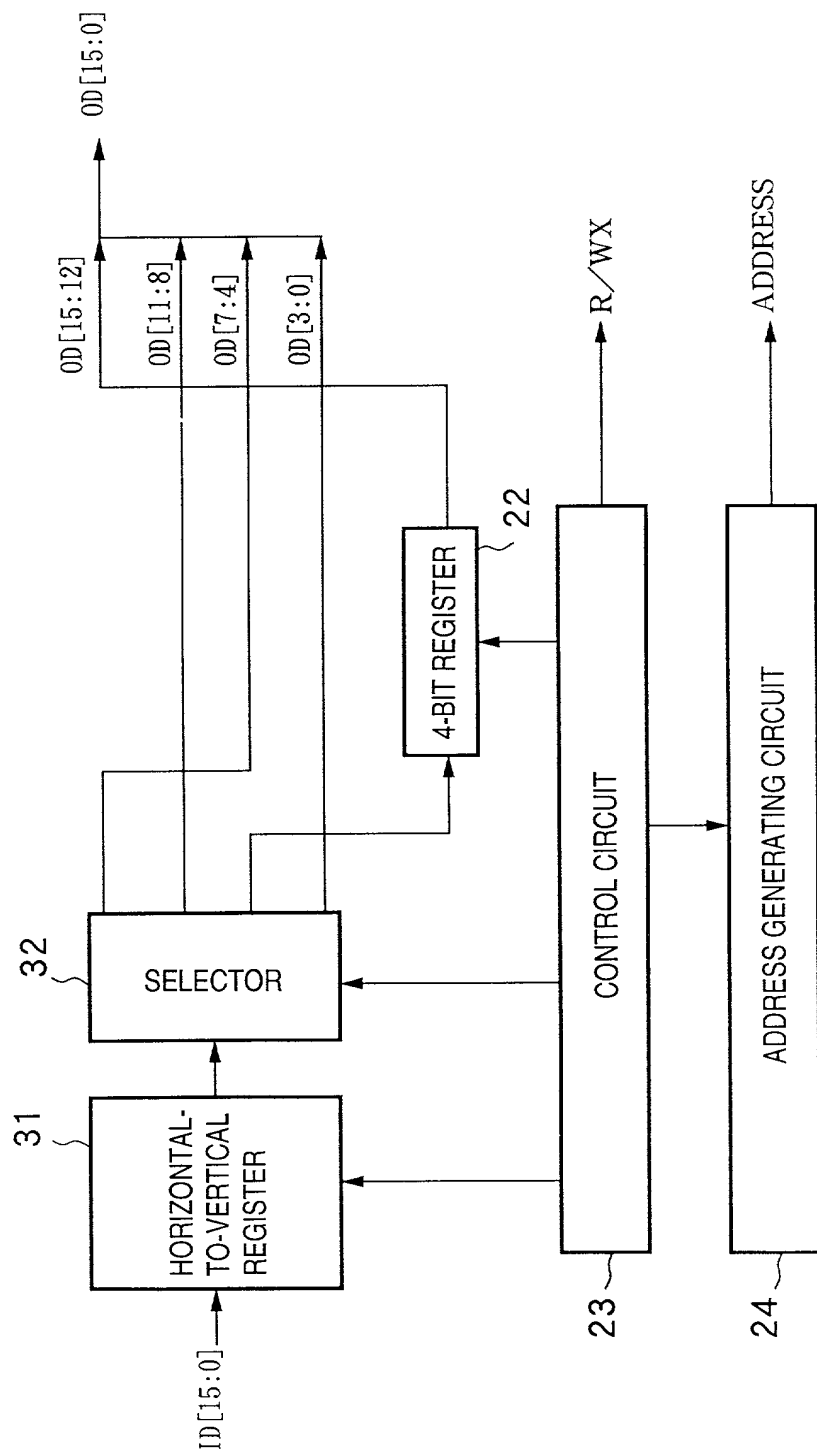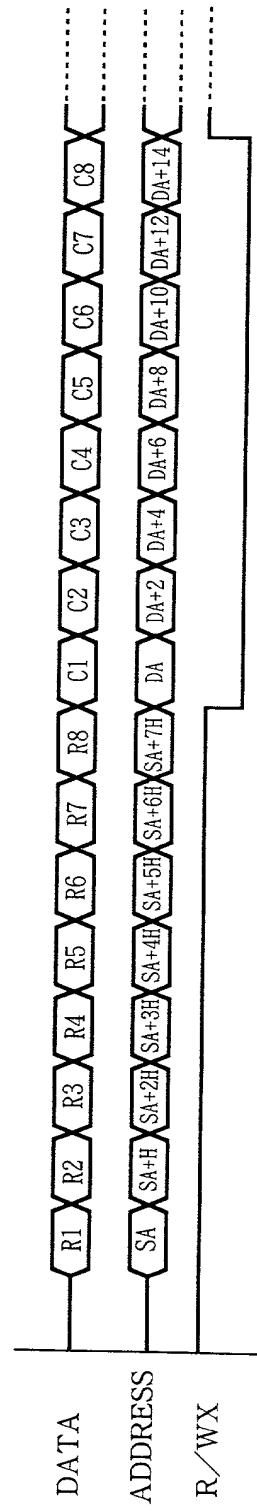
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

DATA PROCESSING METHOD, DATA PROCESSING APPARATUS AND

IMAGE PRINTING APPARATUS   ,

the specification of which [X]is attached hereto. [   ] was filed on_____

as United States Application No. or PCT International Application No. _____
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b), of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designates at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT international application having a filing date before that of the application on which priority is claimed:

Country	Application No.	Filed (Day/Mo./Yr.)	(Yes/No) Priority Claimed
JAPAN	10-219477	03/08/1998	Yes

I hereby appoint the practitioners associated with the firm and customer number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to the address associated with that Customer Number:

FITZPATRICK, CELLA, HARPER & SCINTO
Customer Number: 05514

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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